

Is Axillary Temperature an Appropriate Surrogate for Core Temperature?

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Abstract. The ideal technique for measuring temperature should be rapid, painless, reproducible and accurately reflect the core temperature. While axillary temperature is commonly used because of convenience and safety, there are conflicting reports about its accuracy. To determine whether axillary temperature can act as a surrogate for oral/rectal temperatures, a prospective comparative study was conducted. The axillary and rectal temperatures (Group 1 : infants < 1 year age) and axillary and oral temperatures (Group 2 : children 6-14 years age) were compared using mercury-in-glass thermometers. Various tests of agreement were applied to the data obtained. Rectal and axillary temperatures for infants agreed well; the mean difference (95% limits of agreement) between the two being 0.6°C (-0.3°C, 1.4°C). Similarly, the mean difference (95% limits of agreement) between oral and axillary measurements for children aged 6-14 years was observed to be 0.6°C (-0.4°C, 1.4°C). Axillary temperature appears to be an acceptable alternative to rectal/oral temperature measurements in children. [*Indian J Pediatr* 2000; **67** (8) : 571-574]

Key words : *Temperature measurements; Axillary; Tests of agreement*

Measurement of temperature is probably the commonest clinical procedure performed in a sick child. The ideal technique for measuring temperature should be rapid, painless, reproducible and accurately reflect the core body temperature. Rectal and oral temperatures are considered to provide an accurate approximation of core temperature¹. However, a rectal temperature measurement is inconvenient, unpleasant and potentially dangerous in young children. Oral temperature measurement requires cooperation of the child, which might not be forthcoming in a young child. Axillary temperature measurement is commonly used, as it is safe and convenient; however, there are conflicting reports about its accuracy. There is no universally accepted additive factor to predict rectal/oral temperature using axillary temperature.

Various studies have addressed this question in the past. A large number of studies have used inappropriate analysis^{2,5}. Studies⁶⁻¹¹ which have used the proper tests of agreement¹² have used mainly electronic thermometers and have been done in infants. However, majority of the health care settings use mercury-in-glass thermometers.

The present study was performed to determine whether axillary temperature measurement can serve as an alternative for rectal/oral temperatures using mercury-in-glass thermometers in infants and older children.

MATERIALS AND METHODS

The study was conducted in the pediatric wards, outpatient department and emergency services at AIIMS from February to June 1998. For the purpose of comparing axillary and rectal temperatures, infants < 1 year age were recruited (Group 1). Children between 6 and 14 years of age were studied for comparison of axillary and oral temperatures (Group 2). Preterm neonates, children with local area infection, peripheral circulatory failure or diarrhea were excluded.

The mercury-in-glass thermometers used for the study were calibrated in a water bath that was adjusted to 37°C using a standard thermometer (the thermometers used in the study showed temperatures within 0.1°C of the correct temperature). The ambient temperature was also recorded.

The rectal temperatures (in Group 1) were measured at depth of 2 cm in neonates and 3 cm in infants older than 4 weeks for 3 minutes⁷. Oral temperatures were recorded (in Group 2) by positioning the bulb of the thermometer in the sublingual pocket for 3

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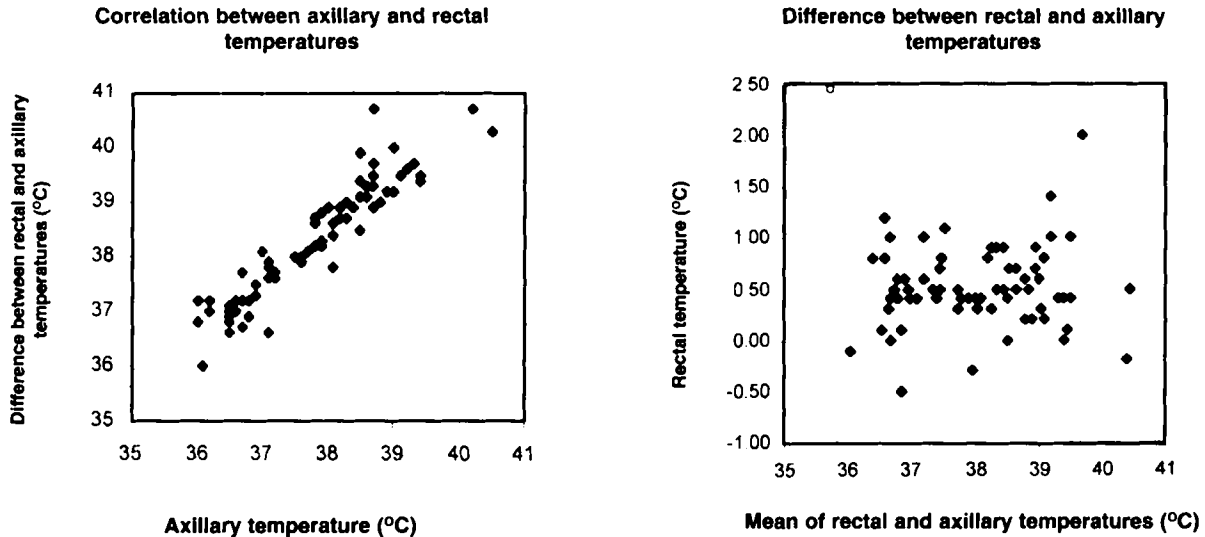


Fig. 1. Agreement between rectal and axillary temperatures.

minutes. Axillary temperature was obtained in all the subjects (Groups 1 and 2) by placing the bulb of mercury-in-glass thermometer midway between anterior and posterior axillary folds for 3 minutes⁷. The two temperatures were taken consecutively, by two different observers. In addition, the nutrition status and the diagnosis were also recorded. Data about the oral intake prior to the oral measurement was recorded for children in Group 2.

The data was analyzed using intercooled version of STATA 5.0 software. The axillary temperature was correlated to the rectal (Group 1) and the oral (Group 2) temperatures. Paired differences between the two temperatures were calculated for the two groups separately. The limits of agreement were calculated using the method suggested by Bland and Altman¹².

RESULTS

A. Comparison of axillary and rectal temperatures in infants (Group 1)

Eighty-one infants (boys 49, girls 32) were studied; the mean age was 5.3 months. Thirty percent of the infants sought care for fever alone, 16% had lower respiratory tract infection, and 25% had upper respiratory tract infection. All infants had clothing appropriate for the weather; none of them was bundled. The rectal temperature in these infants varied between 36.0°C and 40.7°C (mean 38.4°C ± 1.1°C). The axillary temperatures ranged from 36.0°C to 40.5°C (mean 37.9°C ± 1.02°C).

The mean of the paired differences between rectal

and axillary temperatures was 0.6°C (0.4°C), the range being -0.5°C to 2.0°C. Ninety five percent of the differences were between -0.3°C and 1.4°C (Fig. 1). There was a high degree of positive correlation ($r = 0.93$) between the rectal and axillary temperatures (Fig. 1). The following linear relationship between rectal and axillary temperatures was derived from regression analysis:

$$\text{Rectal temperature} = 0.99 \times \text{axillary temperature} + 0.82.$$

Corrected axillary temperatures were obtained by adding 0.6°C to the measured axillary temperature. This had sensitivity of 98% and specificity of 90% for diagnosing fever (rectal temperature >38°C).

B. Comparison of axillary and oral temperatures in children 6-14 years of ages (Group 2)

Axillary and oral temperatures were recorded in 80 children of the age group of 6-14 years. The oral temperatures ranged from 35.9°C to 39.5°C (mean 37.4°C ± 0.7°C). The axillary temperatures varied between 35.4°C to 39.3°C. (mean 36.9°C ± 0.8°C).

The mean (SD) of paired differences between the oral and axillary temperatures was 0.6°C (0.5°C), the range being -0.5°C to 2°C. The 95% limits of agreement were -0.4°C and 1.4°C (Fig. 2). The following linear equation was obtained by regression analysis ($r = 0.83$) to establish a relation between oral and axillary temperatures (Fig. 2): Oral temperature = 0.7 × axillary temperature + 11.49.

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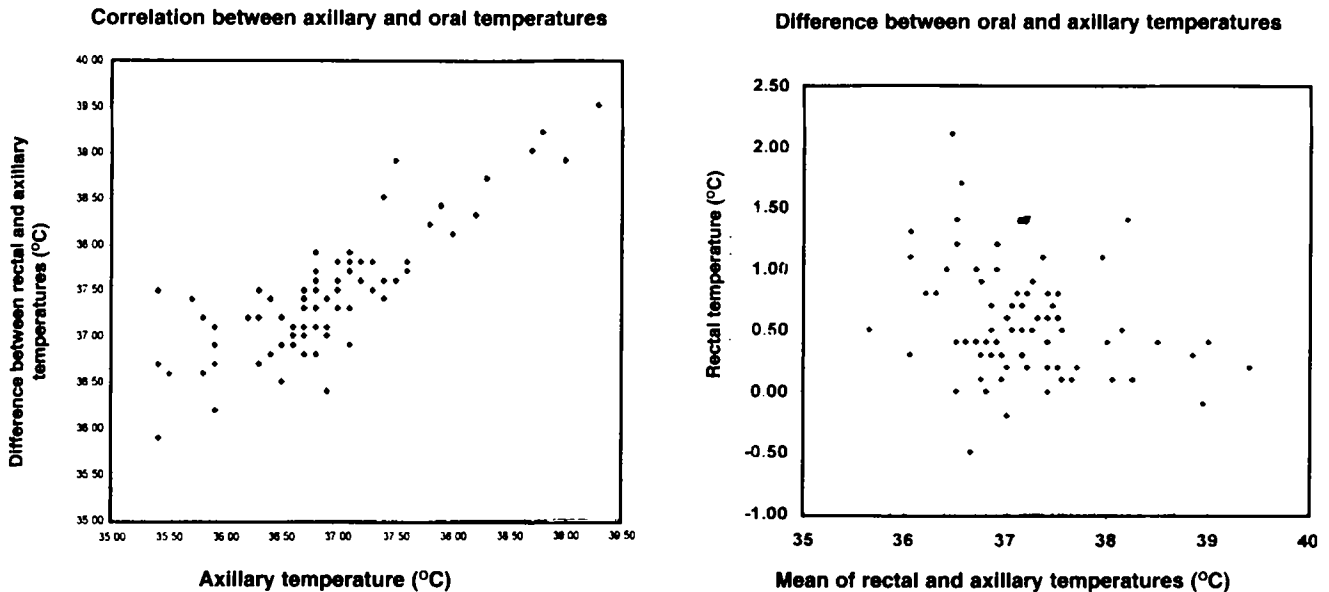


Fig. 2. Agreement between oral and axillary temperatures.

DISCUSSION

We have found a high degree of agreement between rectal and axillary temperatures in infants and between oral and axillary temperatures in older children. The 95% limits of agreement for rectal and axillary temperatures were between -0.3°C and 1.4°C . Similarly, for oral and axillary temperatures, the 95% limits of agreement were 0.4°C and 1.4°C . We also observed that corrected axillary temperatures had high sensitivity and specificity in diagnosing fever in infants.

Using similar analysis, other workers have shown that axillary temperature is an acceptable alternative to rectal measurement though the differences between the two were variable⁵⁻¹¹. However, in most of the studies, the emphasis was given on neonates and often, electronic thermometers were used. In our study, both infants and older children were studied and mercury-in-glass thermometers were used, as these are the ones commonly utilized. In other studies, axillary and rectal temperatures were compared using sensitivity and specificity analysis or correlation analysis^{2,3} and in these studies, axillary temperatures was found to be inaccurate. Correlation analysis is inappropriate as it simply measures the strength of relationship between two measurements, and not the agreement between them¹². Sensitivity and specificity are inappropriate methods of analysis as they ignore the degree of difference between two measurements.

The available studies comparing oral and axillary temperature in children^{4,5} have used inappropriate analyses for agreement (correlation or sensitivity/

specificity). These studies had suggested that axillary temperature was a poor predictor of oral temperature.

Rectal measurements are greatly influenced by the depth of insertion of the thermometer¹³; this may be difficult to control in routine practice. Axillary temperature is less likely to be affected by variations in technique.

As temperature varies from person to person and with age¹⁴, great accuracy in temperature measurement may not be necessary. Our study suggests that axillary temperature measurement is an acceptable alternative to rectal/oral measurements. An attempt should be made to determine the normal range of axillary temperatures for children in different age groups. This will lead to the proper definition of fever using axillary temperatures.

REFERENCES

1. Lorin M. Measurement of body temperature. *Semin Pediatr Infect Dis* 1993; 4 : 4-18.
2. Martyn KK, Urbano MT, Hayes JS, von Windeguth B, Sherrin T. Comparison of axillary, rectal and skin-based temperature assessment in preschoolers. *Nurse Pract* 1988; 13 : 31-36.
3. Kresch MJ. Axillary temperature as a screening test for fever in children. *J Pediatr* 1984; 104 : 596-599.
4. Masters JE. Comparison of axillary, oral and forehead temperature. *Arch Dis Child* 1980; 55 : 896-898.
5. Ogren JM. The inaccuracy of axillary temperatures measured with an electronic thermometer. *Am J Dis Child* 1990; 144 : 109-111.
6. Shann F, Mackenzie A. Comparison of rectal, axillary

- and forehead temperatures. *Arch Pediatr Adolesc Med* 1996; 150 : 74-78.
7. Mayfield SR, Bhatia J, Nakamura KT, Rios GR, Bel EF. Temperature measurement in term and preterm neonates. *J Pediatr* 1984; 104 : 271-275.
 8. Haddock B, Vincent P, Merrow D. Axillary and rectal temperatures of full term neonates : Are they different? *Neonatal Network* 1986; 5 : 36-40.
 9. Schiffman RF. Temperature monitoring in the neonate : A comparison of axillary and rectal temperatures. *Nurs Res* 1982; 31 : 274-277.
 10. Morley CJ, Hewson PH, Thornton AJ, Cole TJ. Axillary and rectal temperature measurements in infants. *Arch Dis Child* 1992; 67 : 122-125.
 11. Anagnostakis D, Matsaniolis N, Grafakos S, Sarafidou E. Rectal-axillary temperature difference in febrile and afebrile infants and children. *Clin Pediatr* 1993; 32 : 268-272.
 12. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986; i : 307-310.
 13. Editorial. Hazards of temperature taking. *BMJ* 1970; 3 : 4-5.
 14. Bayley N, Stolz HR. Maturational changes in rectal temperatures of 61 infants from 1 to 36 month. *Child Dev* 1937; 8 : 195-206.

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